the crucible-supporting rod is controlled on the basis of changes in heat flow rate calculated by the detected temperature.--

REMARKS

Claims 33-36, 39, 56 and 57 are now presented for examination. Claims 33-36 and 39 have been amended to define still more clearly what Applicant regards as his invention. Claims 1-32, 37, 38 and 40-55 have been cancelled without prejudice. Claims 56 and 57 have been added to provide Applicant with a more complete scope of protection.

Claims 33-36, 39 and 57 are the independent claims.

Claims 33 to 36 and 39 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite, because they depended from non-elected claims. As shown above, those claims have been re-written as independent claims, obviating the rejection.

Claims 33-36 and 39 were rejected under 35 U.S.C. § 103 as obvious from U.S. Patent 5,037,621 (Kennedy et al.) in view of U.S. Patent 6,123,764 (Mizugaki et al.).

Claims 33-36 and 39 have been amended to define more clearly Applicant's invention. Applicant submits that amended Claims 33-36 and 39, together with new independent Claim 57, are patentable over the prior art for at least the following reasons.

Claim 33 is directed to a process for producing a crystal article, comprising producing the crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible, and a moving means, comprising a crucible-supporting rod, for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with a detector for detecting temperature of the growth

material; and controlled on the basis of changes in temperature detected by the detector. A movement rate of the crucible moved by the moving means, a temperature distribution of the heater for heating the crucible and a temperature of the crucible-supporting rod constituting the moving means are controlled on the basis of changes in temperature detected by the detector such that the isothermal face of the growth material is kept convex on the side of a liquid phase.

Claim 34 is directed to a process for producing a crystal article, comprising producing the crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with a plurality of detectors for detecting temperature of the growth material, which are provided at an underside of the crucible in a plane that intersects the direction of crystal growth; and controlled on the basis of the temperature detected by the plurality of detectors; being so controlled that the isothermal face of the growth material is kept convex on the side of a liquid phase. The plurality of detectors are set in positions different from each other in radius direction of the underside of the crucible.

Claim 35 is directed to a process for producing a crystal article, comprising producing the crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with a

measuring means for measuring a rate of heat flow in the crystal growth furnace; and controlled on the basis of changes in heat flow rate measured with the measuring means. A temperature in the crucible and a movement rate of the crucible moved by the moving means are controlled such that the heat flow rate and the movement rate are in proportional relation to one another.

Claim 36 is directed to a process for producing a crystal article, comprising producing the crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with a detecting means for detecting generation of latent heat of the growth material; and controlled on the basis of information given from the detecting means on the generation of latent heat. A temperature in the crucible and a movement rate of the crucible moved by the moving means are controlled such that an amount of latent heat and the movement rate are in proportional relation to one another.

Claim 57 is directed to a process for producing a crystal article, comprising producing the crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible, and a moving means, comprising a crucible-supporting rod, for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with plural detectors for detecting temperature of the growth material; and controlled on the basis of changes in temperature detected by the

detectors. The detectors detect temperature of at least two points of the crucible-supporting rod or a member set to the crucible-supporting rod and temperature of the crucible-supporting rod is controlled on the basis of changes in heat flow rate calculated by the detected temperature.

Kennedy, as undersood, is directed to a method of crystal growth. The Examiner relied upon Kennedy as teaching, among other things, that the crucible is moved so as to create a crystalline growth front and that the melt is crystallized into a single crystal. However, even if Kennedy is deemed, arguendo, to teach all it is cited for, it is not seen to teach or suggest all of the above-mentioned features of amended independent Claims 33-36 and 57. Mizugaki, relied upon for teaching Bridgeman growth of fluorides to create crystals, is not seen by Applicant as remedying the deficiencies of Kennedy as a reference against Claims 33-36 and 57. Accordingly, Claims 33-36 and 57 are believed patentable over the cited references.

Claim 39 is directed to a process for producing a crystal article, comprising producing a fluoride crystal article by means of an apparatus for producing a crystal article. The apparatus comprises a crystal growth furnace having a crucible for holding a growth material of fluoride, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater. The growth material melted in the crucible is cooled to effect crystal growth. The crystal growth furnace is: provided with a thermocouple comprising a pair of metal wires formed of materials different from each other, and a tube provided around at least one of metal wires. The tube comprises a metal composed chiefly of tantalum; and the crystal growth furnace is controlled on the basis of temperature information attributable to the thermocouple.

Neither of the cited references teaches or suggests the use of the tube formed of tantalum, which, as is shown in the specification at Table 2, is particularly good for measurement of temperature of a crucible for fluoride material. Accordingly, Claim 39 is believed clearly patentable over the cited art.

A review of the other art of record has failed to reveal anything which, in Applicant's opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claim in this application is dependent from independent Claim 34 discussed above and is therefore believed patentable for the same reasons. Since that dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration of its patentability on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicant respectfully requests favorable reconsideration and early passage to issue of the present application.

Applicant's undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

33. (Amended) A process for producing a crystal article, comprising producing the crystal article by means of [the] an apparatus for producing a crystal article [according to claim 1], the apparatus comprising a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible, and a moving means, comprising a crucible-supporting rod, for moving the crucible relatively to the heater; the growth material melted in the crucible being cooled to effect crystal growth, wherein the crystal growth furnace is:

provided with a detector for detecting temperature of the growth material; and

controlled on the basis of changes in temperature detected by the detector; and

a movement rate of the crucible moved by the moving means, a temperature distribution of the heater for heating the crucible and a temperature of the crucible-supporting rod constituting the moving means are controlled on the basis of changes in temperature detected by the detector such that the isothermal face of the growth material is kept convex on the side of a liquid phase.

34. (Amended) A process for producing a crystal article, comprising producing the crystal article by means of [the] an apparatus for producing a crystal article

[according to claim 16], the apparatus comprising a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater; the growth material melted in the crucible being cooled to effect crystal growth, wherein the crystal growth furnace is:

provided with a plurality of detectors for detecting temperature of the growth material, which are provided at an underside of the crucible in a plane that intersects the direction of crystal growth; and

controlled on the basis of the temperature detected by the plurality of detectors; being so controlled that the isothermal face of the growth material is kept convex on the side of a liquid phase, and

the plurality of detectors are set in positions different from each other in radius direction of the underside of the crucible .

35. (Amended) A process for producing a crystal article, comprising producing the crystal article by means of [the] an apparatus for producing a crystal article [according to claim 18], the apparatus comprising a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater; the growth material melted in the crucible being cooled to effect crystal growth, wherein the crystal growth furnace is:

provided with a measuring means for measuring a rate of heat flow in the crystal growth furnace; and

controlled on the basis of changes in heat flow rate measured with the

measuring means, and

a temperature in the crucible and a movement rate of the crucible moved by the moving means are controlled such that the heat flow rate and the movement rate are in proportional relation to one another.

36. (Amended) A process for producing a crystal article, comprising producing the crystal article by means of [the] an apparatus for producing a crystal article [according to claim 32], the apparatus comprising a crystal growth furnace having a crucible for holding a growth material, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater; the growth material melted in the crucible being cooled to effect crystal growth, wherein the crystal growth furnace is:

provided with a detecting means for detecting generation of latent heat of the growth material; and

controlled on the basis of information given from the detecting means on the generation of latent heat, and

a temperature in the crucible and a movement rate of the crucible moved by the moving means are controlled such that an amount of latent heat and the movement rate are in proportional relation to one another.

39. (Amended) A process for producing a crystal article, comprising producing a fluoride crystal article by means of [the] an apparatus for producing a crystal article [according to claim 38], the apparatus comprising a crystal growth furnace having a crucible for

holding a growth material of fluoride, a heater for melting the growth material held in the crucible and a moving means for moving the crucible relatively to the heater; the growth material melted in the crucible being cooled to effect crystal growth, wherein the crystal growth furnace is:

provided with a thermocouple comprising a pair of metal wires formed of materials different from each other, and a tube provided around at least one of metal wires; the tube comprising a metal composed chiefly of tantalum; and

controlled on the basis of temperature information attributable to the thermocouple.

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